Cosmological Perturbations Through a General Relativistic Bounce

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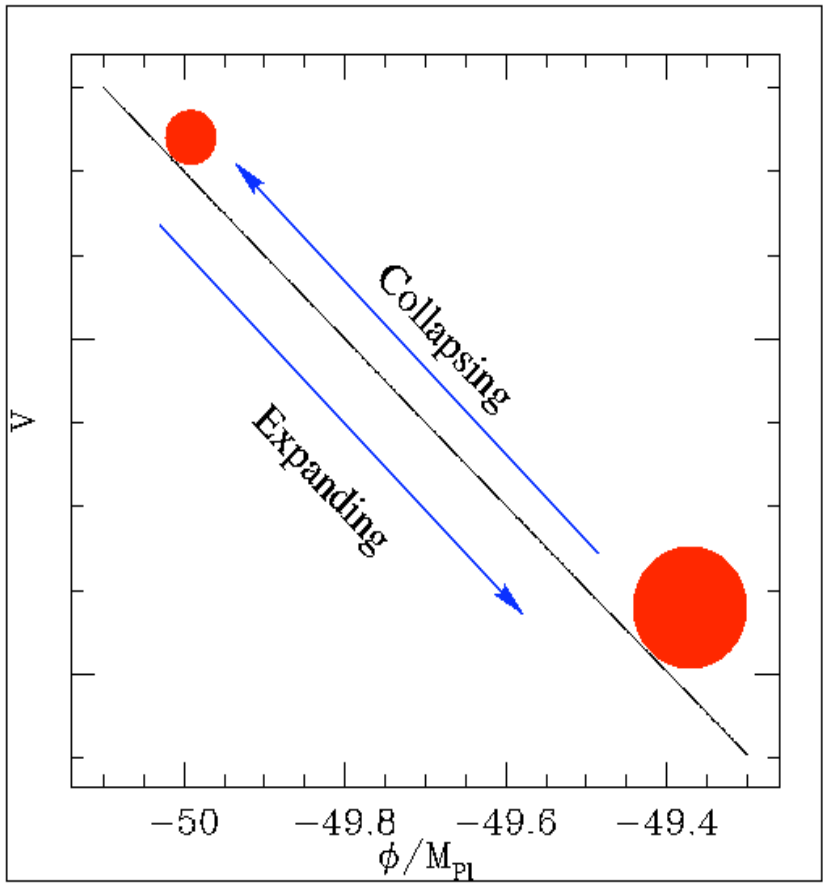
- Reference: C. Gordon and N. Turok, hep- th/0206138.
- Some String/M- theory based cosmologies such as the Ekpyrotic and Pre- Big Bang models can be described by a collapsing Universe which undergoes a bounce to an expanding Universe.
- If the cosmological perturbations were generated in the collapsing phase, it is necessary to know how they propagate through the transition.

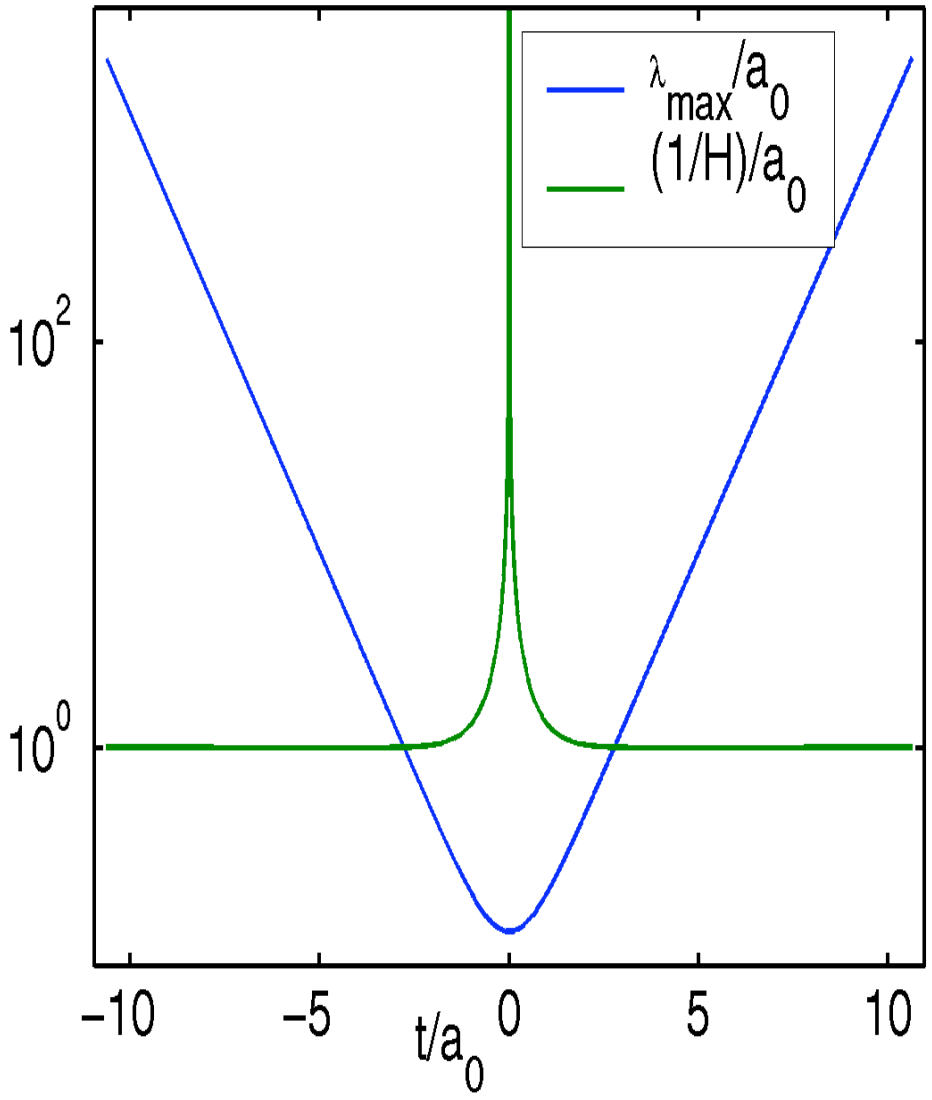
Scalar Field in a Closed Universe

- A closed Universe whose energy density becomes dominated by the potential energy, $V(\phi)$, of a scalar field ϕ can bounce without violating General relativity or the weak energy condition: $\rho+p\geq 0$
- Size of ball in figure proportional to log of scale factor a.
- Time scale = a_0, the scale factor at the bounce.



Cosmological Perturbations

- Comoving curvature perturbation (denoted or) is a good measure of cosmological perturbations
- is constant provided the wavelength of the perturbation is greater than the Hubble length ($1/H$) and the entropy perturbation (S) is negligible
- Figure shows how wave length shrinks smaller than the Hubble length so not constant across bounce.

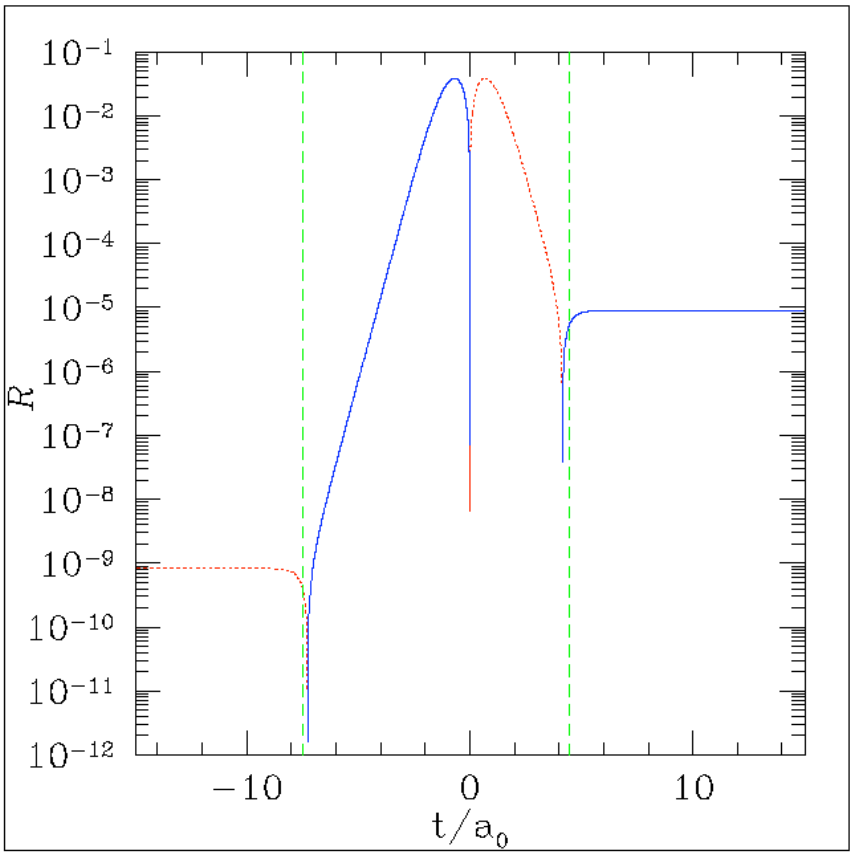


Entropy Perturbation

- The entropy perturbation is given by:

$$\mathcal{S} = H\left(\frac{\delta p}{\dot{p}} - \frac{\delta \rho}{\dot{\rho}}\right)$$

- In the collapsing (expanding) phase the entropy increases (decreases) exponentially.
- Green lines in figure enclose time when the entropy perturbation causes to vary.



Conclusion

- Considered a potential dominated scalar field in a closed Universe. This led to a bounce consistent with General Relativity and the Weak Energy Condition.
- All cosmological perturbations are effected by bounce as
  - All wave lengths become smaller than Hubble length around bounce.
  - The entropy perturbation is amplified around the bounce.
- Shows how in general the bounce mechanism is important in determining the transfer of cosmological perturbations from a contracting to an expanding phase of the Universe.
- Reference: C. Gordon and N. Turok, hep- th/0206138.